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CHEMICAL MECHANICAL POLISHING APPARATUS AND METHOD TO MINIMIZE SLURRY ACCUMULATION AND SCRATCH EXCURSIONS

FIELD OF THE INVENTION

The present invention relates generally to chemical mechanical polishing and, more particularly, to polishing pad cleaner for in-situ cleaning.

BACKGROUND OF THE INVENTION

CMP is a process for improving the surface planarity of a semiconductor wafer and involves the use of mechanical pad polishing systems usually with a silica-based slurry. CMP offers a practical approach for achieving the important advantage of overall wafer planarity.

CMP systems place a semiconductor wafer in contact with a polishing pad that rotates relative to the semiconductor wafer. The semiconductor wafer may be stationary, or it may also rotate on a carrier that holds the wafer. Problems of conventional methods of performing a chemical mechanical polish is that they produce nonuniform wafers and produce larger than desirable edge exclusion areas. Both of these problems impair operation of resulting electronic components formed from the semiconductor devices. Semiconductor

wafer non-uniformity may cause undesirable layers not to be removed at some places and desirable layers to be removed at other places on the wafer surface. This causes various areas on the wafer surface to be unusable for forming semiconductor devices. Process uniformity from wafer to wafer is also important in CMP processing. Known CMP systems, however, suffer from significant wafer-to-wafer non-uniformities. This can also adversely affect the throughput and yield of the CMP process. To achieve a low defect rate, each successive substrate should be polished under similar conditions.

Another limitation of existing CMP systems relates to a part of the system known as the CMP polish pad. The silica-based slurry is applied to the CMP polish pad to lubricate the interface between the wafer and the CMP polish pad. The slurry also serves the function, because of its silica content, of mildly abrading or affecting the surface of the semiconductor wafer. Relative motion of the polishing pad with respect to the wafer effectuates polishing of the wafer through mechanical abrasion and chemical etching. The amount of mechanical abrasion is determined in part by the size of the abrasive particles in the slurry. Often, during the polishing process, the particles conglomerate forming larger particles which can scratch or otherwise effect the polishing. Changes in the slurry solution properties, such as the particle sizes, have a profound effect on the polishing chemistry and relative removal rates of dielectric films if not properly removed from the pad.

One of the factors that is accounted for in returning the polishing pad to its condition prior to the polishing of another wafer is the removal from the polishing pad of the debris, such as conglomerated slurry, created during the polishing period. These debris may be on

the surface of the polishing pad or trapped within grooves of the polishing pad. If the debris are left on and within the pad, the polishing conditions for the next wafer to be polished will be different from the previous wafer that was just polished.

A typical method of removing the debris from the polishing pad after a wafer has been polished is to employ a spray rinse over a portion of the surface of the polishing pad. The spray rinse provides a de-ionized water to the pad in hopes of washing away all the debris from the polishing pad following a wafer polishing phase. In another approach, described in U.S. Patent No. 6,224,470, a pad cleaning brush is used in conjunction with spray rinse water. Although conventional spray rinse approaches and the above-mentioned cleaning brush apparatus provide some measure of cleaning to the polishing pad, some debris can remain behind within the center area of the polishing pad.

SUMMARY

The present invention achieves technical advantages as an apparatus and system used in conjunction with rinse water to thoroughly clean a polishing pad of a chemical-mechanical polishing apparatus after a wafer has been polished. A sprayer or sprayer extension is strategically positioned and securely retained on a portion of the dispensing arm and adapted for applying a rinse water spray directly to the center portion of the pad preventing conglomerated slurry from accumulating.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying drawings wherein:

Figure 1 illustrates a conventional chemical-mechanical polishing system 100; and

Figures 2A-2C illustrate spray extensions in accordance with exemplary embodiments of the present invention.

DETAILED DESCRIPTION

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses and innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features, but not to others. Throughout the drawings, it is noted that the same reference numerals or letters will be used to designate like or equivalent elements having the same function. Detailed descriptions of known functions and constructions unnecessarily obscuring the subject matter of the present invention have been omitted for clarity.

Referring now to Figure 1 there is shown a conventional chemical-mechanical polishing system 100 that employs a polishing pad cleaning device. The cleaning device 100 includes a rotatable (rotation direction is shown by the arrow) platen on which a polishing pad 110 is disposed. A drive device is adapted for and used to bring a wafer 120 into mechanical contact with the pad 110 and rotate the wafer 120 in the opposite direction. During a polishing operation, the device may also move the wafer 120 in a linear motion across the surface of the polishing pad 110 in which a portion of the wafer 120 is in mechanical contact with the center most portion of the pad 110. The wafer 120 is pressed against the pad 110 at a predetermined pressure. During polishing, a slurry is

dispensed in droplets onto the surface of the pad 110 to effectuated the chemical mechanical removal of materials from the wafer 120 surface.

The slurry composition and the pressure applied between the wafer surface and the polishing pad 110 determine the rate of polishing or material removal from the wafer surface. A slurry composition typically includes a colloidal suspension of oxide particles suspended in an alkali solution. Other abrasive components such as ceria suspensions may also be used. During a CMP process, a large volume of a slurry composition is delivered by a dispensing arm 130 positioned over the surface of the polishing pad 110 as the pad 110 is rotated.

After the wafer 120 has been polished and moved to the next station or from the CMP apparatus 100, the polishing pad 110 is cleaned by a spray of de-ionized water. Typically the dispensing arm 130 is also used to deliver the spray. Conventionally, the spray is delivered by several nozzles forming a typical spray pattern shown as item 140. The centrifugal force from the rotation and the de-ionized water are cooperable for carrying away the debris from the polishing pad 110. Although the typical spray pattern 140 of de-ionized water is adequate to clean most of the debris from a polishing pad, a slurry build-up occurs at the center most portion of the pad 110 of conventional wash approaches. This build-up often includes a conglomeration of the slurry material which is problematic for subsequent polishing of wafers 120 in a sequence process.

In order to overcome the above-stated concern of cleaning debris more thoroughly from the polishing pad, the present invention provides a spray extension advantageously positioned to thoroughly spray the entire center portion 150 of the pad 110 while the pad is being rotated acting to more thoroughly clean the debris from the polishing pad 110, wherein the extension further does not interference with other hardware during the process.

A cross-sectional side view of spray extensions in accordance with exemplary embodiments of the present invention is provided in Figures 2A-2C. Referring now to Figure 2A there is shown a spray extension 210 coupled to a conventional dispensing arm 130 and shown in relation with the center portion 150 of the pad 110. In this embodiment, the spray extension 210 is adapted to have a profile such that no part of the extension extends over the end of the dispensing arm 130. Further, the extension is provided with a directional spray nozzle which enables water to be sprayed directly on the pad center 150.

Referring now to Figure 2B there is shown another spray extension 220. In Figure 2B, this spray extension 220 extends the nozzle beyond the dispense arm 130 and points the de-ionized water spray directly over the center 150 of the pad. This maximizes the spray force from the fluid velocity in dislodging the slurry conglomerates and cleaning the pad 110. The water spray angle should be at 90 degrees relative to the pad

surface. System 230 allows adjustments to be made on the extension for adequate pad coverage.

Referring now to Figure 2C there is shown another spray extension 250. In Figure 2C, the extension is another form that allows easy installation by using 'off the shelf', currently available components for high purity plumbing. The extension 250 includes a conventional plumbing collar 240 coupling two pieces of pipe such that adjustments can be made on the extension for adequate pad coverage from the water spray. This design also allows optimal cleaning in that the de-ionized water spray from the extension 250 is positioned directly over the pad center 150 to maximize fluid energy.

Although exemplary embodiments of the invention are described above in detail, this does not limit the scope of the invention, which can be practiced in a variety of embodiments.